Calibration of Booster BPMs using IPM, and measurement of quad center relative to BPMs

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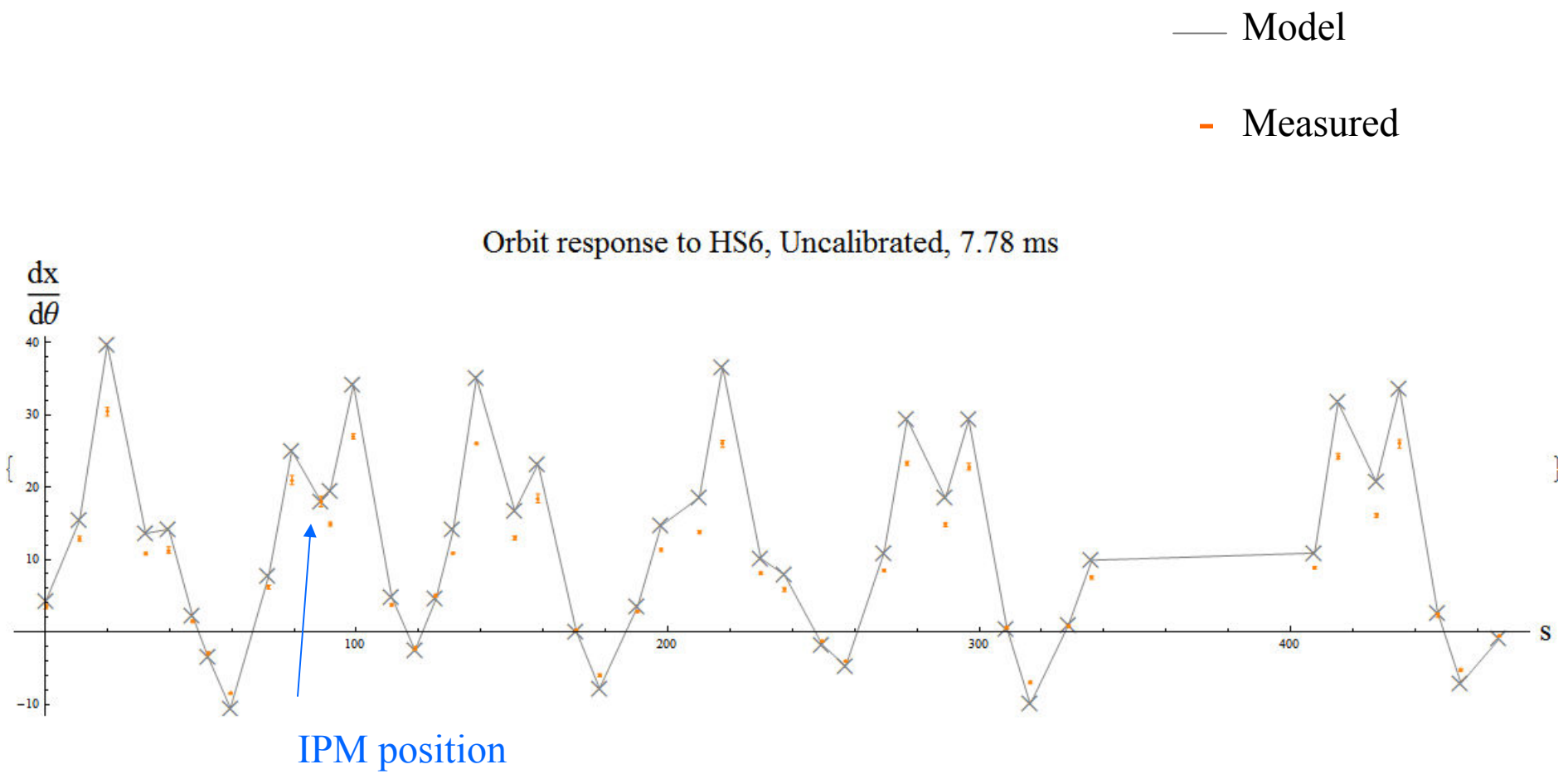
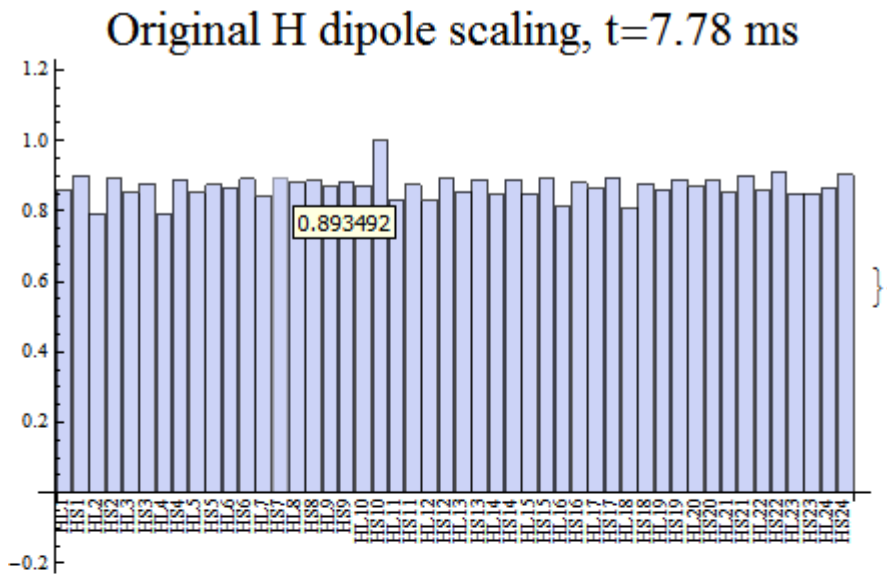
3/14/12

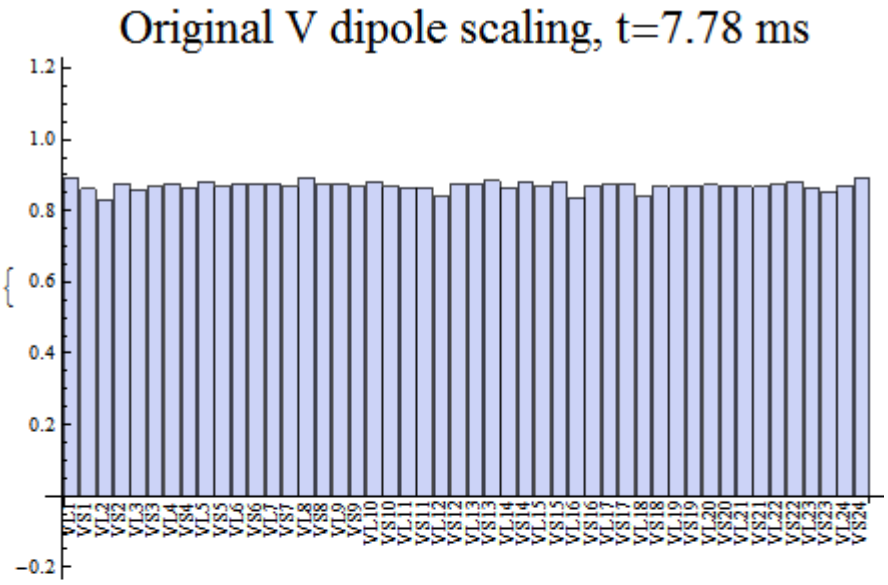
Part 1:
Calibration of BPMs using ionization profile monitor

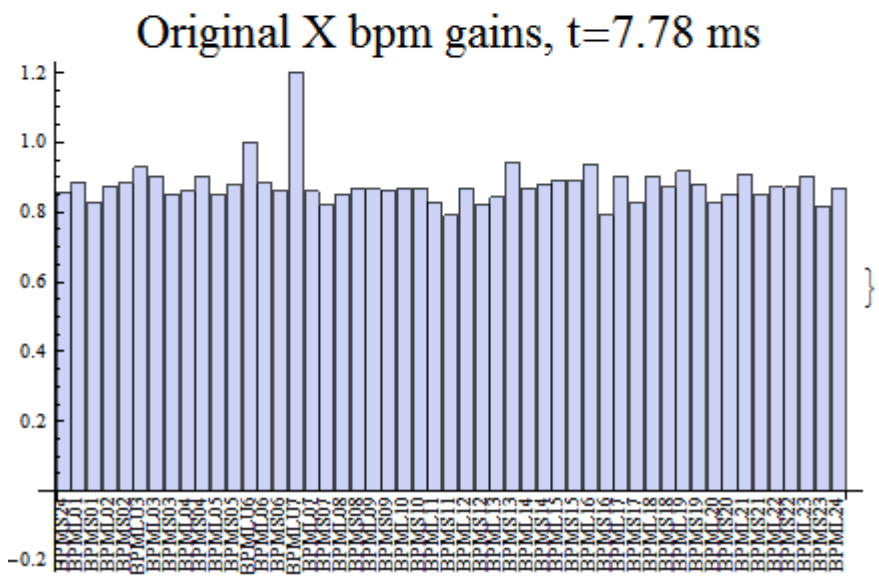
Measurements of orbit response are about 20% smaller than the response predicted by our model.

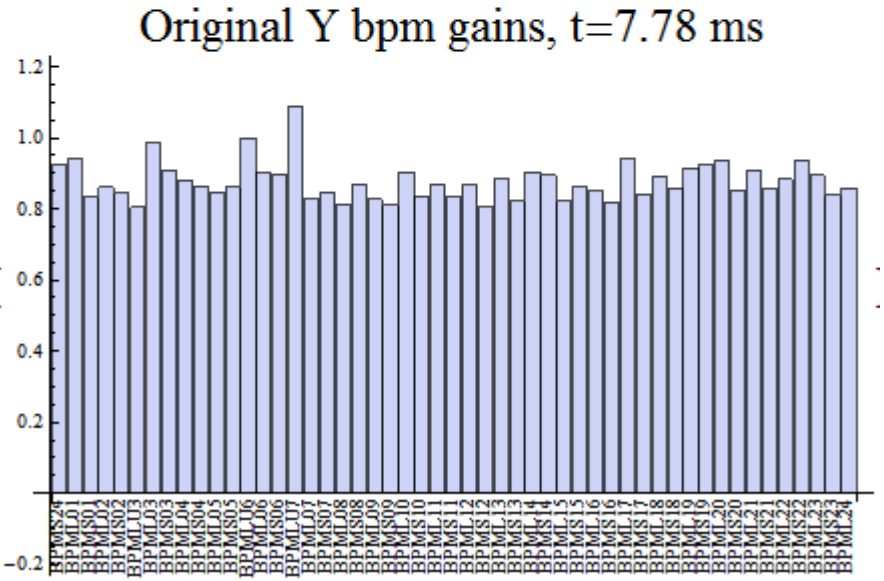


Scaling factors found using LOCO method, to make measurements best agree with model:



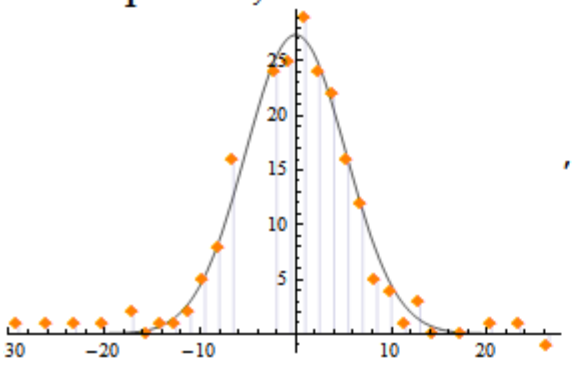




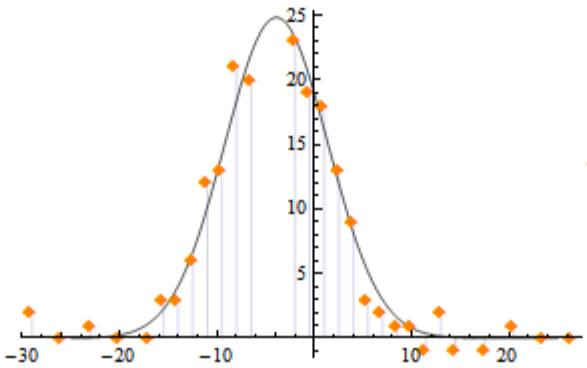


Examples of recorded ionization profiles:

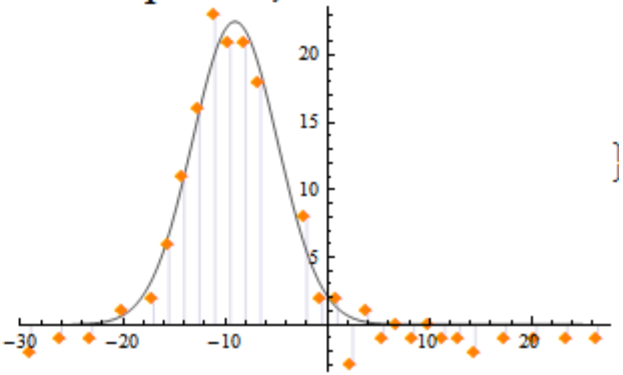
X profile, turn #100.



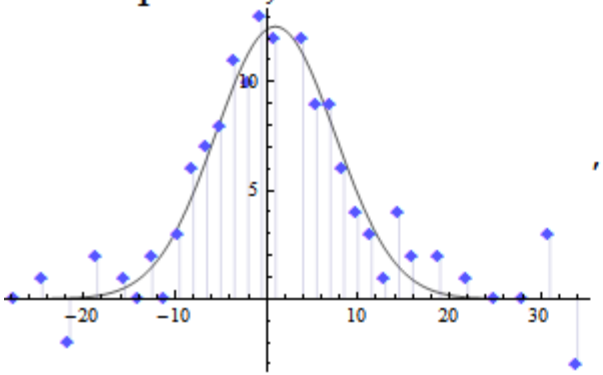
X profile, turn #2100.



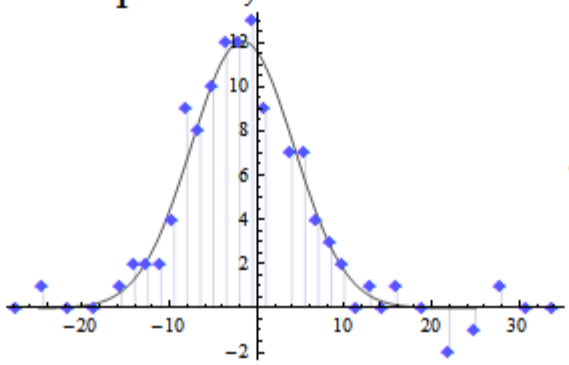
X profile, turn #4100.



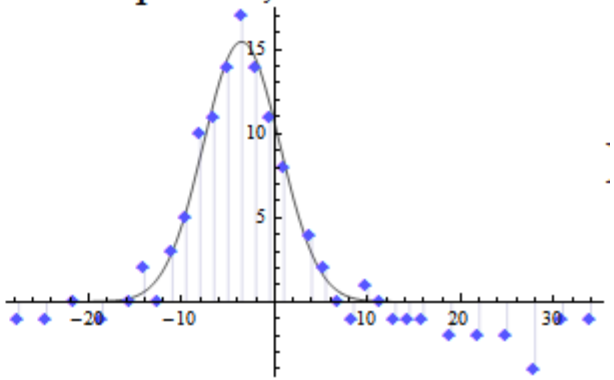
Y profile, turn #100.



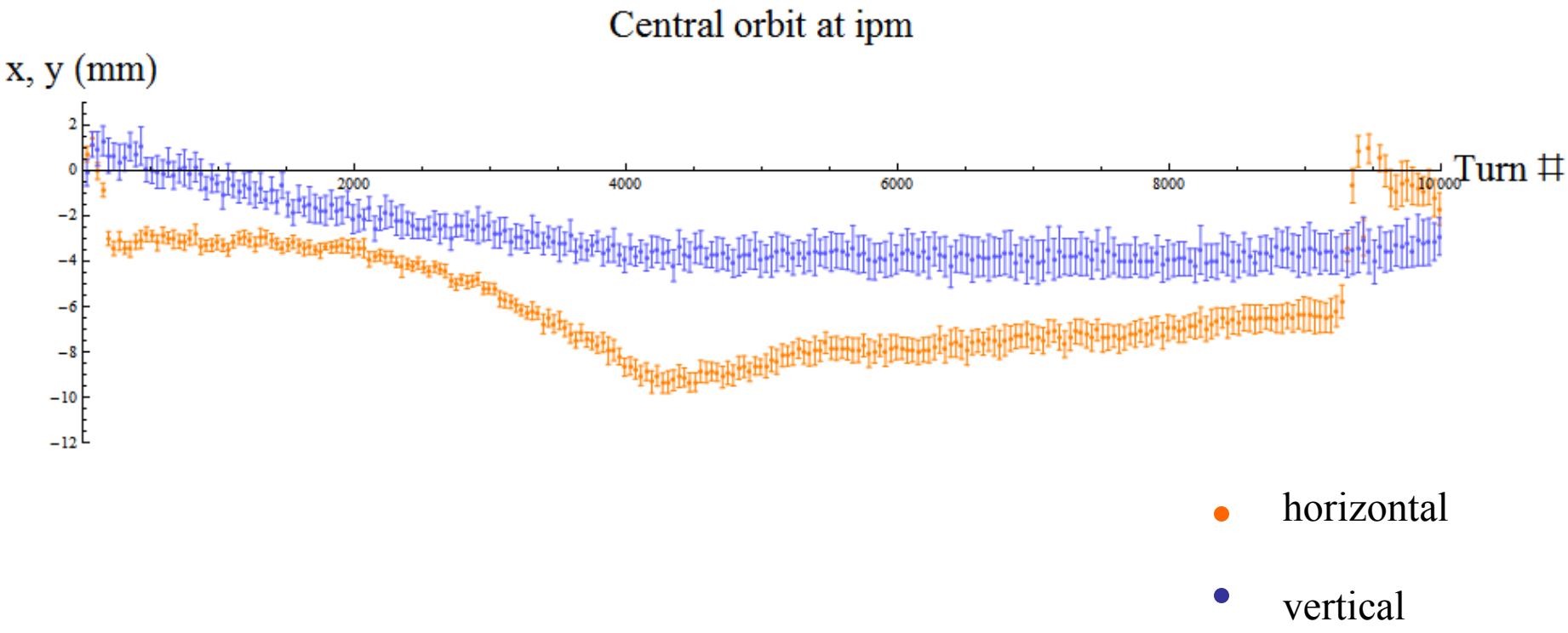
Y profile, turn #2100.



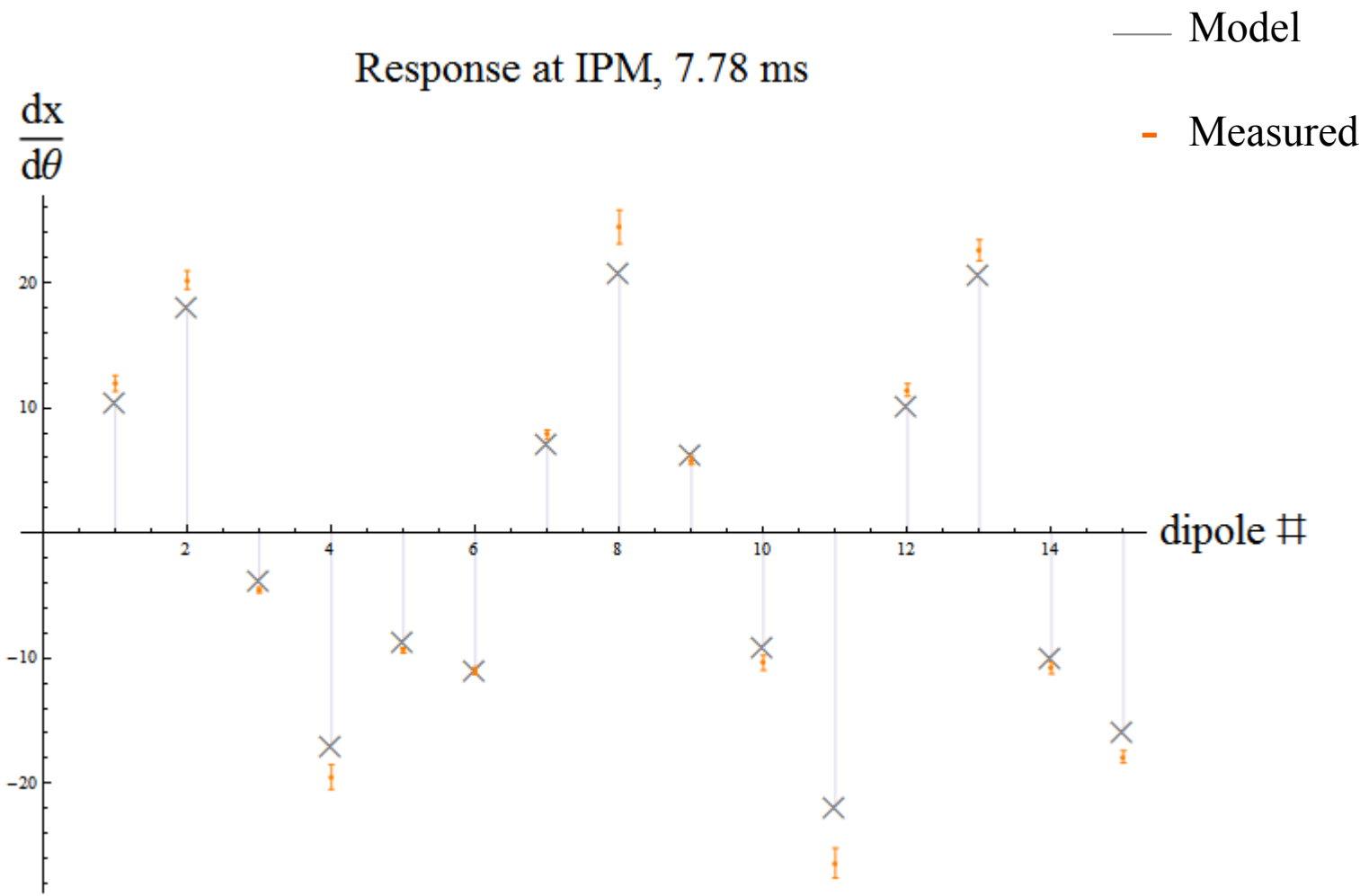
Y profile, turn #4100.



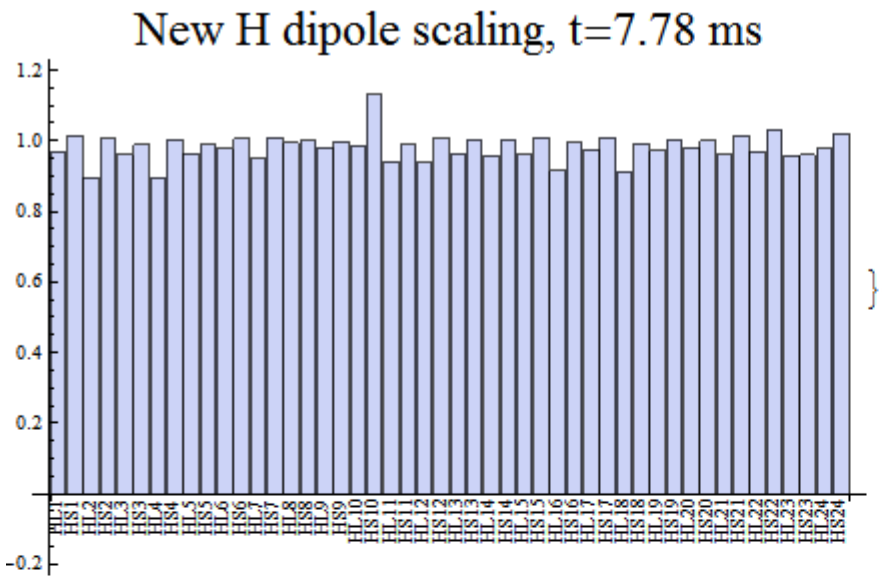
Beam centroid position at IPM, from Gaussian fit of profile:

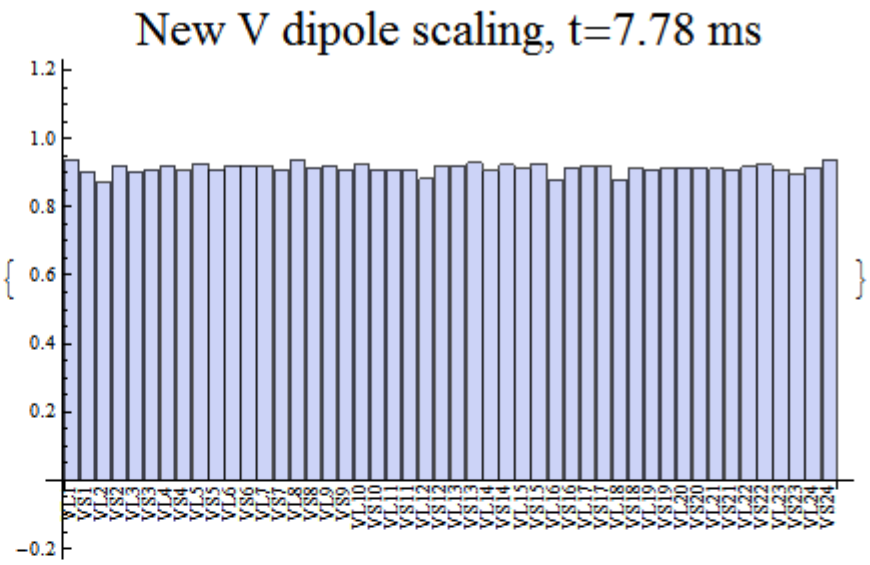


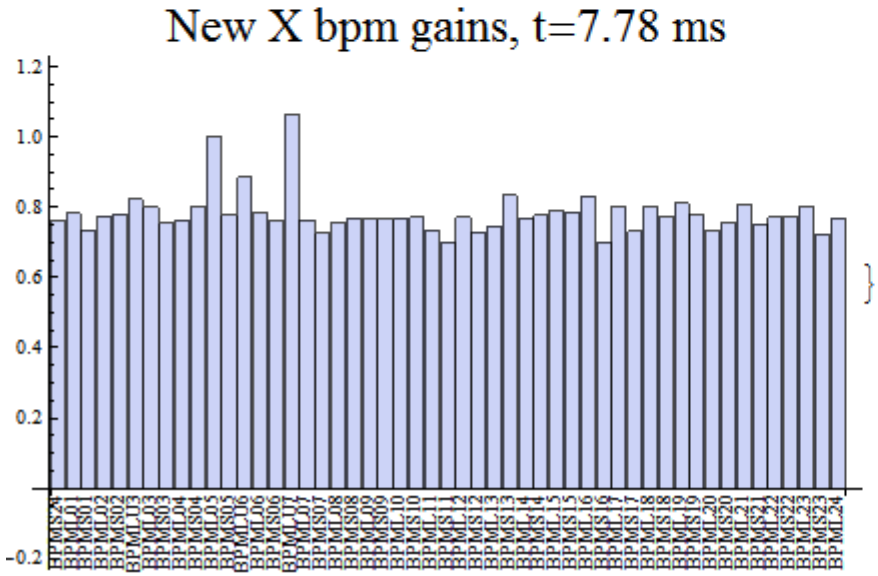
Measured orbit responses at IPM, and expected values from original calibration of model

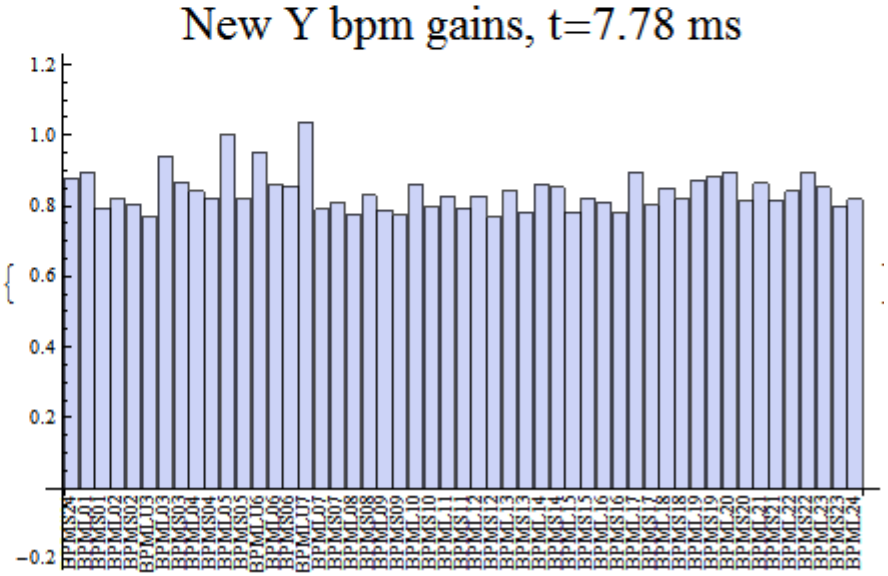


Adjusted calibrations, using ipm position to fix dipole calibration



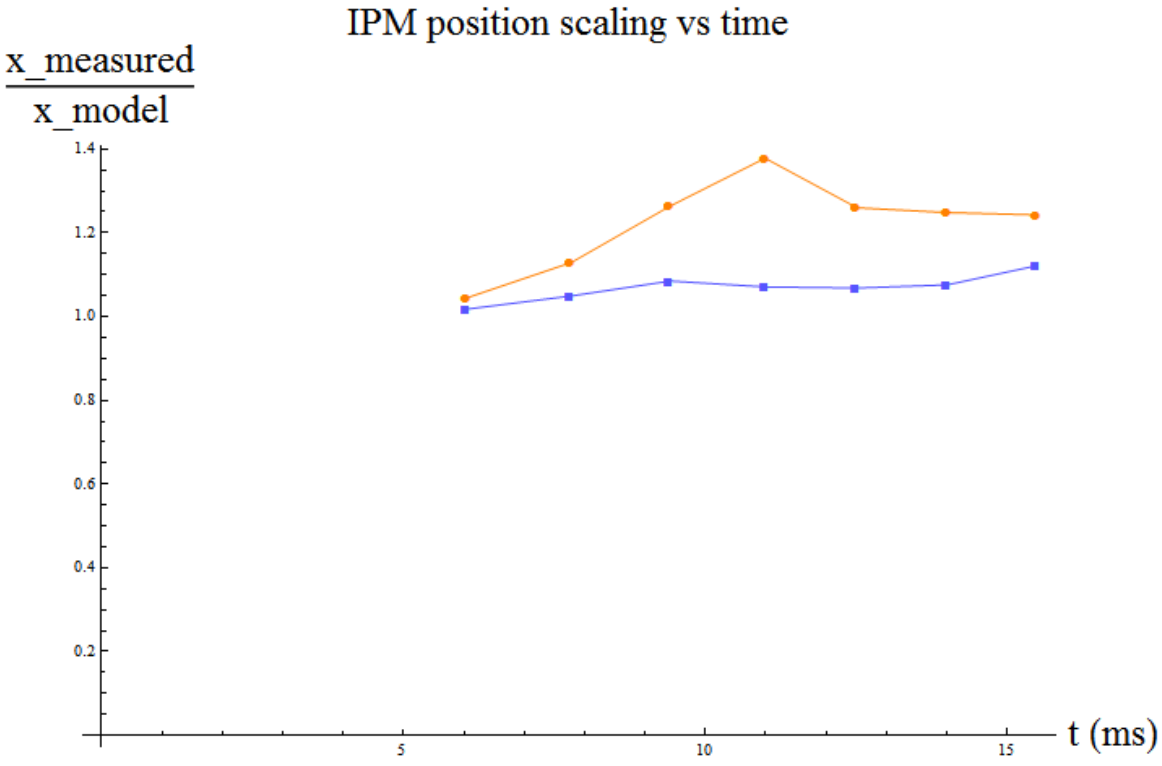


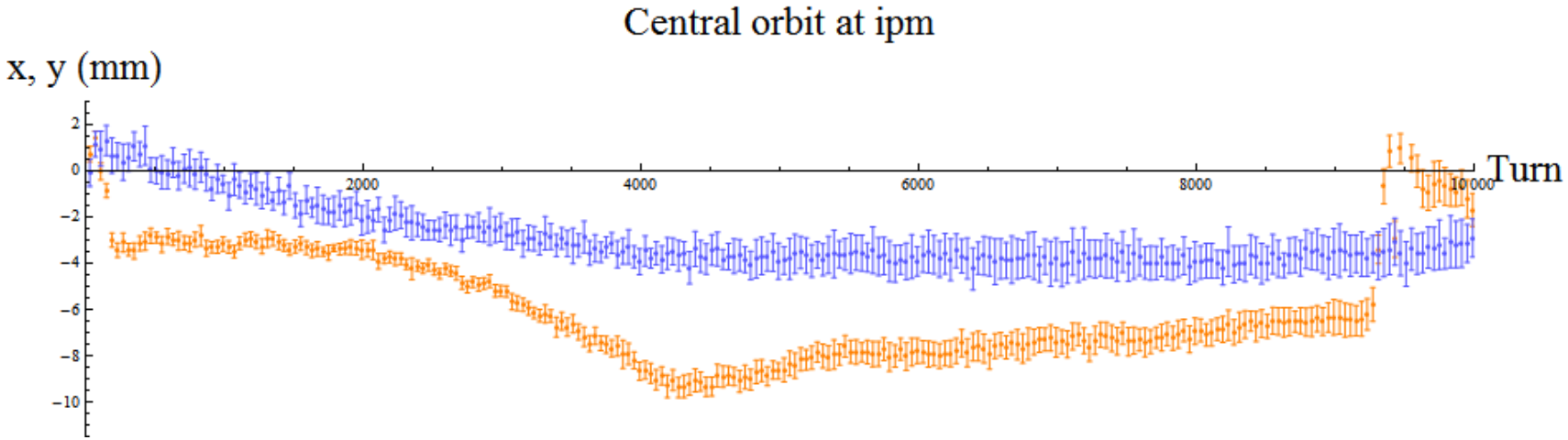




How accurate is the position given by the ipm?

Several channels in the ipm are dead; accuracy of fit may vary depending on location of beam centroid relative to dead channels.





Part 2:
Measurement of orbit relative to quad magnet center

Orbit Response to Quadrupole bumps:

Solving for the closed orbit with a quadrupole error gives an expression similar to the solution with a dipole error (to first order):

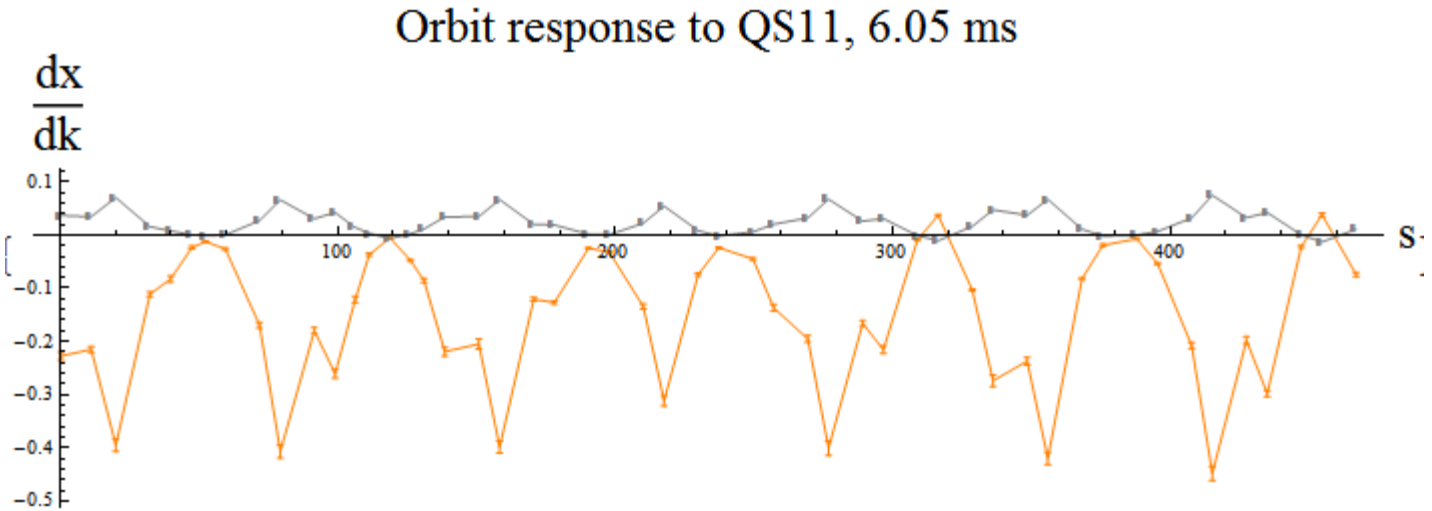
$$M \cdot \begin{pmatrix} 1 & 0 \\ -\delta k & 1 \end{pmatrix} \cdot \begin{pmatrix} x \\ x' \end{pmatrix} + \begin{pmatrix} 0 \\ -x0\ \delta k \end{pmatrix} == \begin{pmatrix} x \\ x' \end{pmatrix}$$

$$\frac{\delta x}{\delta k} \simeq -\frac{x0\ \beta}{2\ \mathrm{Sin}[\pi \nu]}\ \mathrm{Cos}[\pi \nu]$$

Measured orbit response, and expected response based on BPM position:

Model, using (calibrated) bpm position

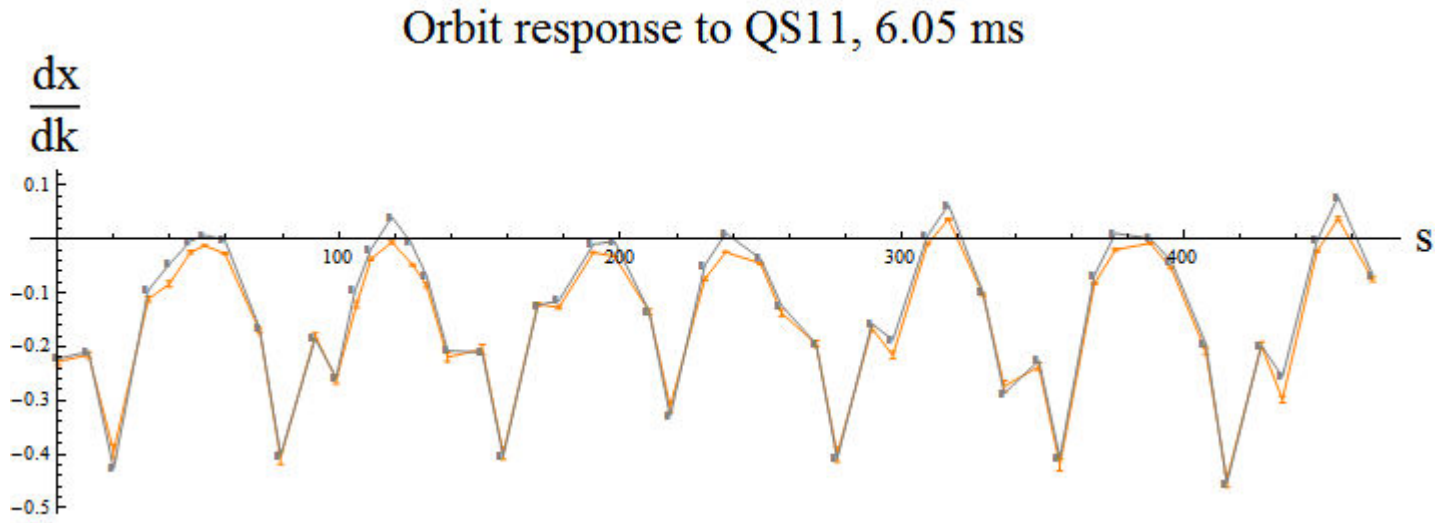
Measured



Measured orbit response, and expected response based fitted position relative to quad center:

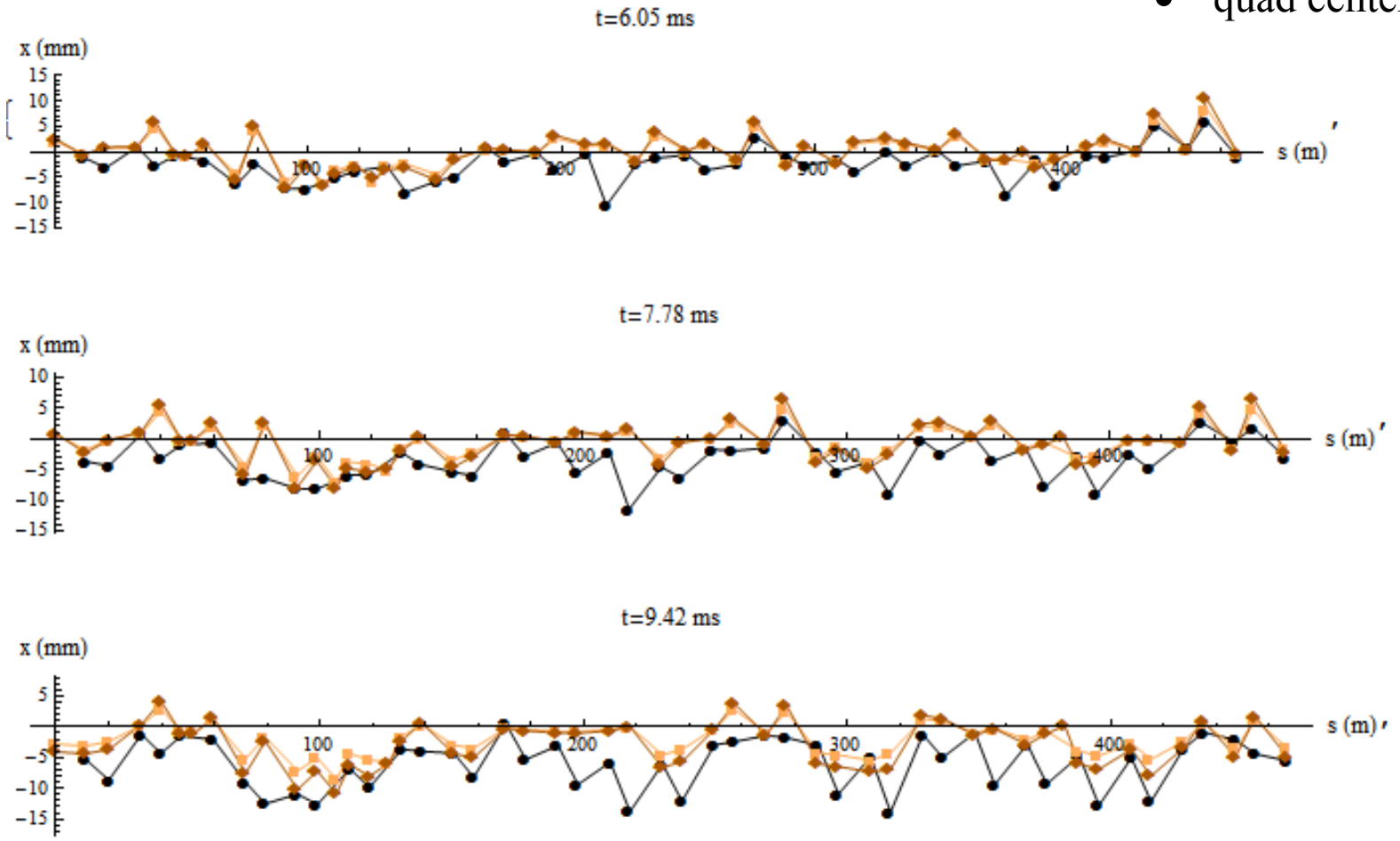
Model, using best-fitting position relative to quad

Measured



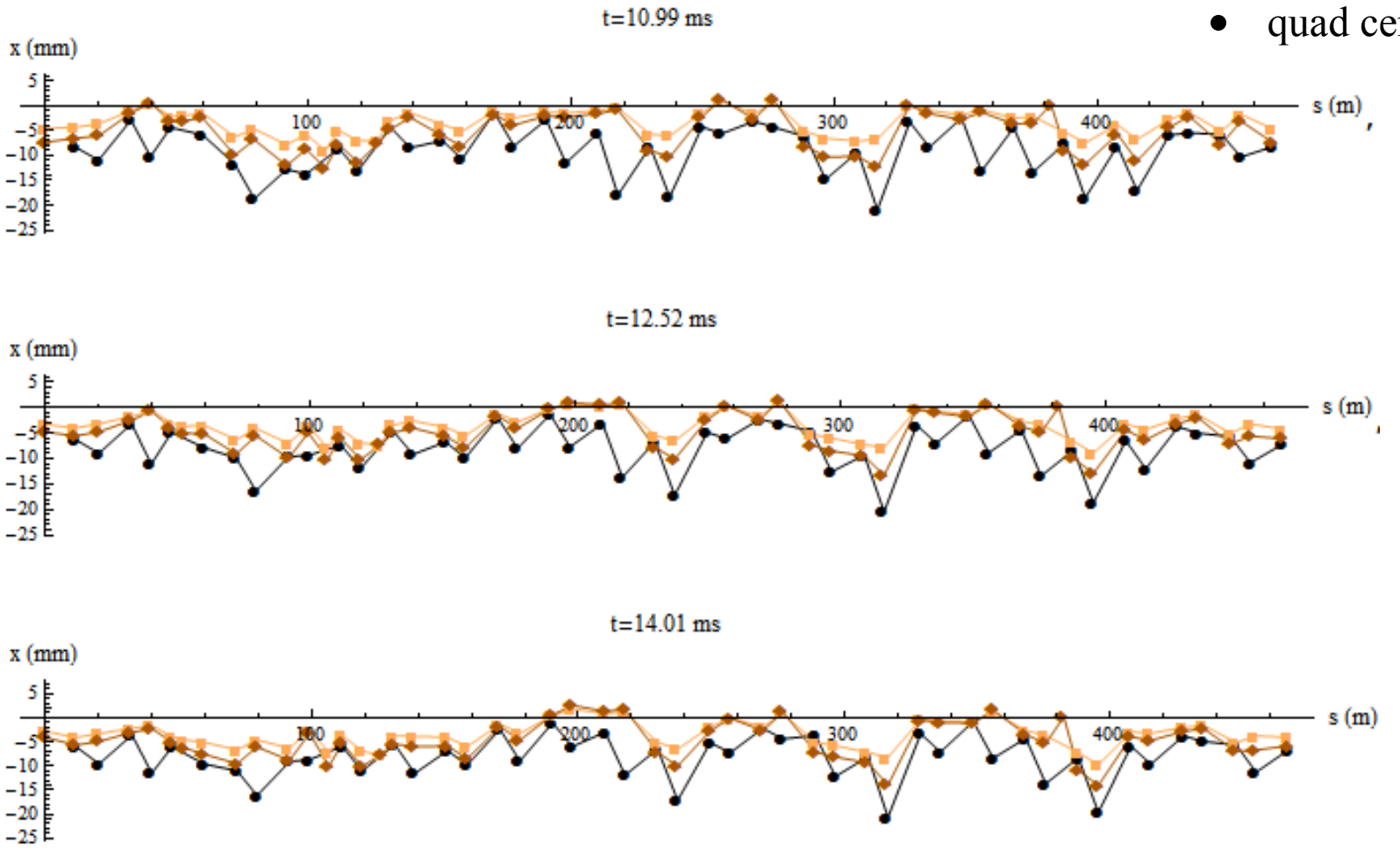
Central orbit, measured by BPMs and by quad steering

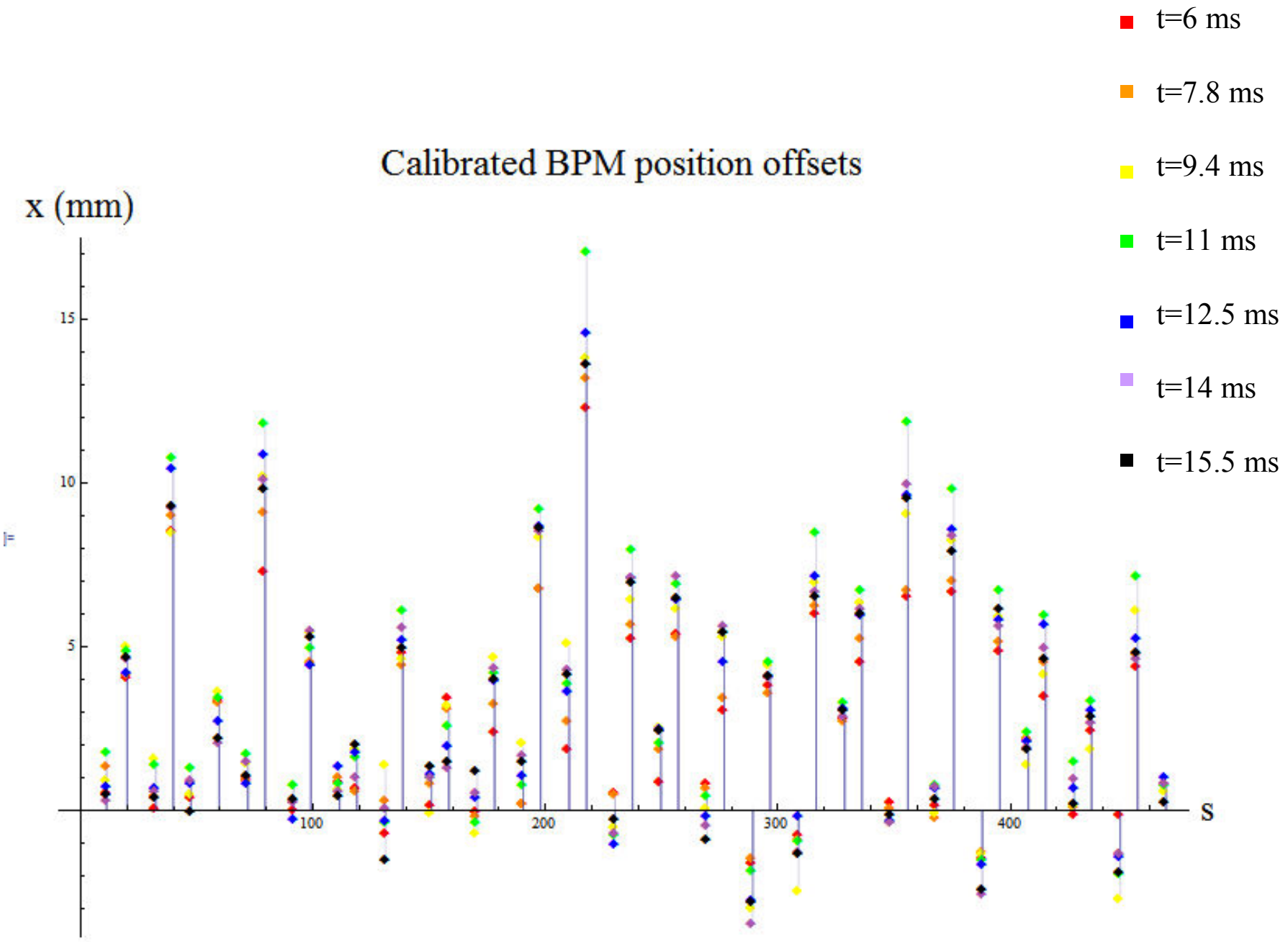
- bpm (uncorrected)
- bpm (calibrated)
- quad center



Central orbit, measured by BPMs and by quad steering

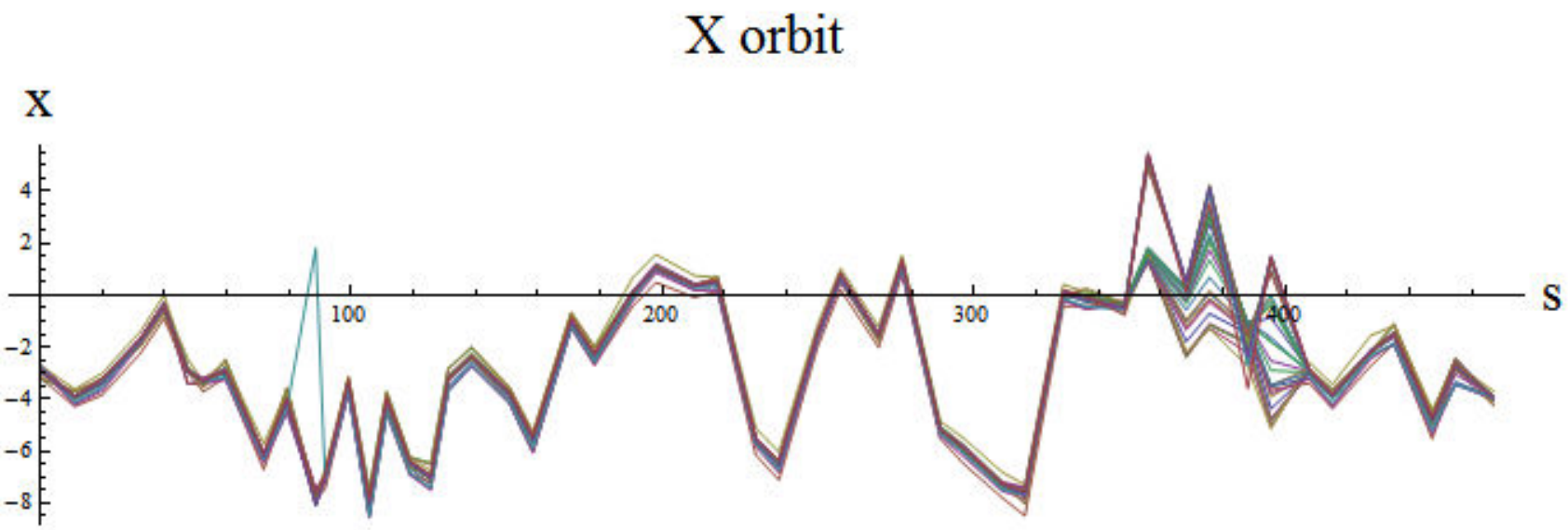
- bpm (uncorrected)
- bpm (calibrated)
- quad center

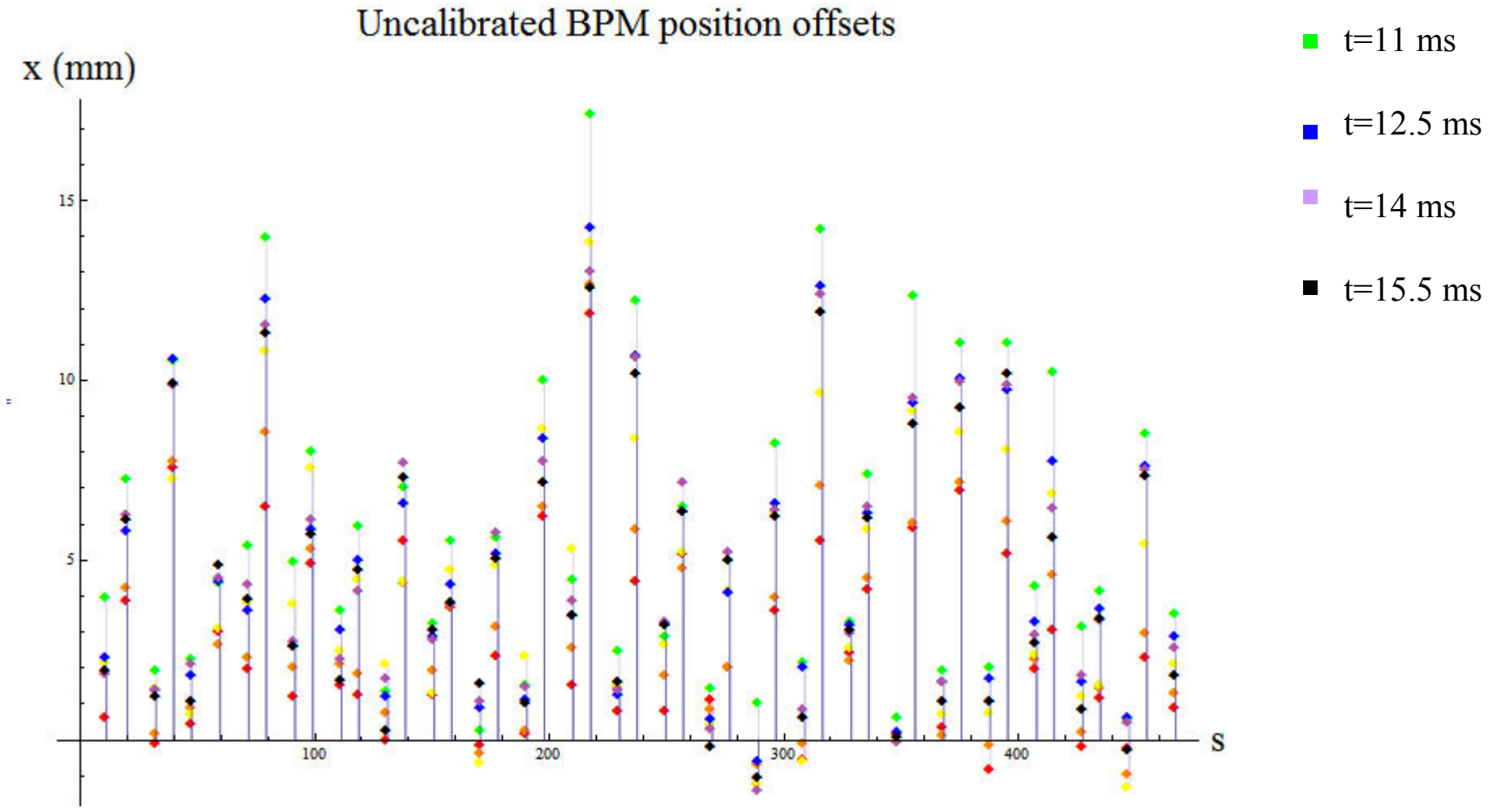



Calibrated BPM position offsets
x (mm)
15
10
5
100
200
300
400
S
t=6 ms
t=7.8 ms
t=9.4 ms
t=11 ms
t=12.5 ms
t=14 ms
t=15.5 ms

Extra Slides

BPM errors, sections 18-20




Uncalibrated BPM position offsets
x (mm)
15
10
5
100
200
300
400
S
t=6 ms
t=7.8 ms
t=9.4 ms
t=11 ms
t=12.5 ms
t=14 ms
t=15.5 ms